(12) UK Patent Application (19) GB (11) 2 098 098 A

(21) Application No 8210454
(22) Date of filing 8 Apr 1982
(30) Priority data
(31) 3301526
3338651
(32) 10 Apr 1981
14 Oct 1981
(33) Soviet Union (SU)
(43) Application published
17 Nov 1982
(51) INT CL³
B04B 5/00
(52) Domestic classification
B2P 10C3B2 9D3
(56) Documents cited
None
(58) Field of search
B2P

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(54) Centrifuge for cleaning working fluids of hydraulic systems

(57) A centrifuge for cleaning working fluids of hydraulic systems comprises a sleeve 6 carrying a drum member 5 enclosed by a casing 7. The sleeve 6 is journalled in bearings 3, 4 on a vertical hollow axle 2 fixedly secured on a base 1 of the centrifuge. Tangentially arranged slots 11 are provided in the vertical hollow axle 2 to deliver under pressure a working fluid being cleaned into the drum 5 through ports 12 in the sleeve 6 arranged to face the slots 11. Mounted inside the drum member 5 concentrically therewith is a thin-wall perforated cylinder 21, a portion 23 of the wall of the cylinder 21 in the lower section thereof to face the slots 11 in the axle 2 being non-perforated. The clean fluid is discharged through tangentially converging ports 13 in the sleeve, slots 14 in the axle, a pipe 18 and an outlet 9.

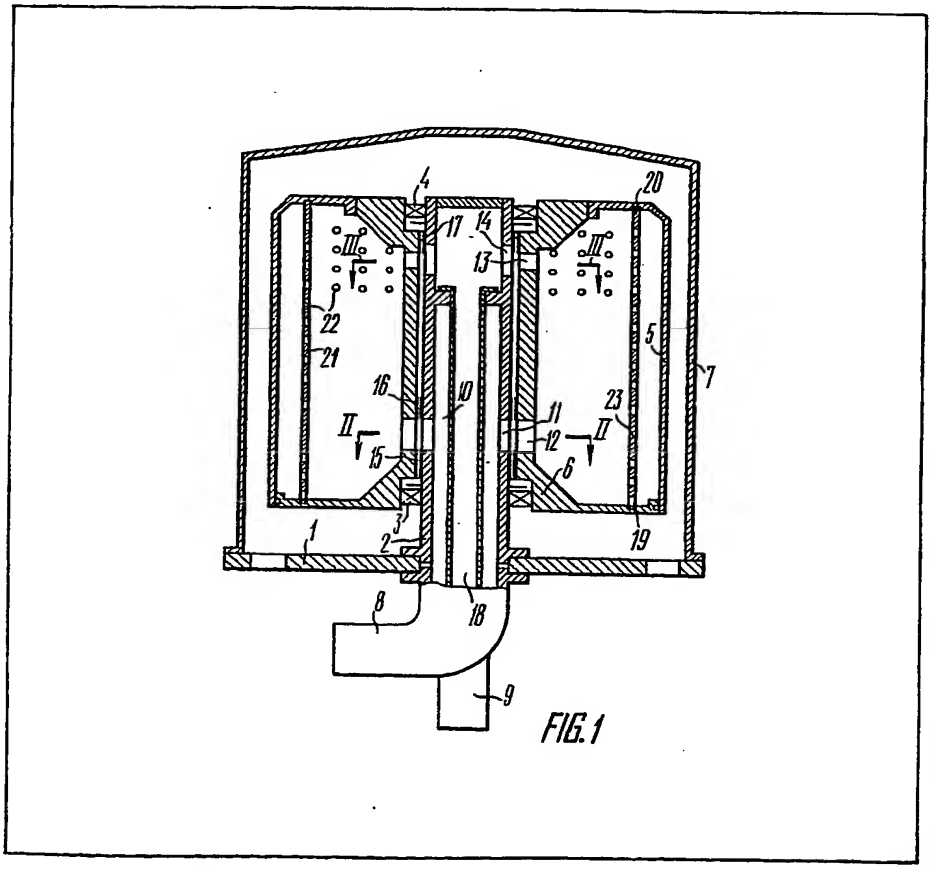

FIG. 1

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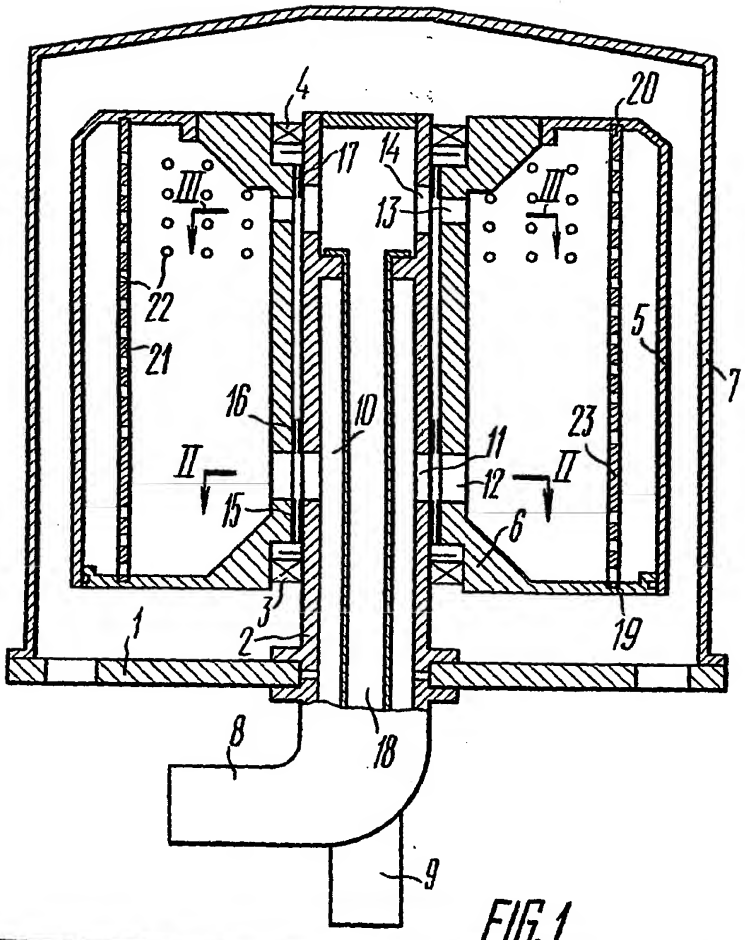

FIG. 1

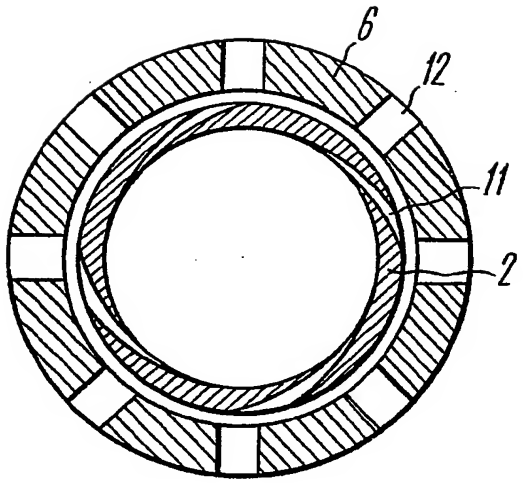

FIG. 2

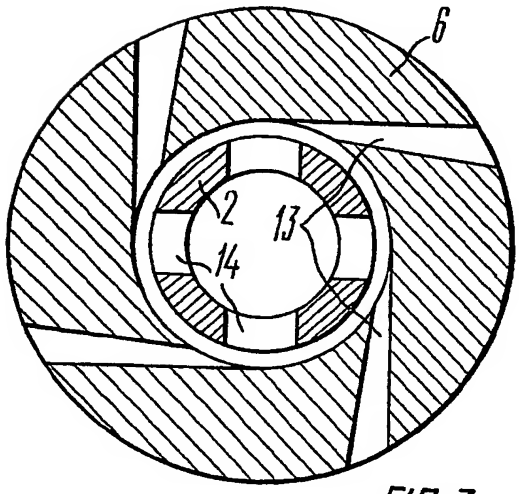

FIG. 3

SPECIFICATION

Centrifuge for cleaning working fluids of hydraulic systems

This invention relates to devices for cleaning working fluids in hydraulic drives and lubrication systems of vehicles and equipment, and more specifically to centrifuges for cleaning working fluids of hydraulic systems.

A centrifuge embodying the present invention can find application in lubrication systems of internal combustion engines, in fuel and hydraulic systems of vehicles, and in production processes for cleaning oils and fuels from solid impurities.

It is a common knowledge that the service life and reliability of vehicles, machine tools, hydraulic presses and other equipment depends largely on the degree of purity of the working fluids used in hydraulic systems, lubricating oils and fuels. A great attention is therefore devoted nowadays to designing devices capable to meet the ever growing requirements to the purity of working fluids.

The problem is becoming even more acute in view of the continuing trend to use higher and higher pressures in hydraulic systems.

Cleaning of working fluids used in hydraulic systems is at present effected either by means of various filters with paper, mesh or other elements, or in devices making use of force fields, such as gravitational, magnetic, electrostatic, centrifugal and the like.

Impurities formed in the course of operation of the hydraulically driven equipment in working fluids consist of predominantly metal and quartz particles.

The modern hydraulic systems employ hydraulic equipment designed for rated pressures of 20 MPa or more with gaps between cooperating parts within 10 to 25 mkm. Therefore, working fluid cleaning means must effectively remove metal and quartz particles sized above 10 mkm.

It is known that the use of filters capable of retaining particles sized between 10 and 15 mkm is disadvantageous in view of increased production and operational costs involved caused by short service life and low contamination retaining capabilities thereof. Therefore a much wide use have found lately centrifugal cleaners which provide practically any desired degree of purity of the working fluid and feature relatively simple design and low operational costs.

The designation and specifics of application of centrifugal cleaners instead of filters or in combination therewith evolved certain structural peculiarities, particularly in terms of the way such cleaners are driven. Normally, they are driven by the flow of the working fluid being cleaned, which is generally a suspension of low particles concentration.

There is known an oil cleaning centrifuge internal combustion engines of the "Mann und Hummel" Company of the Federal Republic of Germany (cf., West G rman Pat. No. 1,123,625, Cl. 82 b 7, published August 10, 1962).

The centrifuge comprises a base with a casing, a vertical stationary hollow axle wherethrough a fluid to be cleared is admitted to the interior of a rotating drum member journalled in bearings on the axle. The drum is driven by a hydraulic motor of the Segner's wheel type and mounted in a separate chamber underlying the drum member.

This centrifuge construction is inherently bulky and heavy due to the provision of a chamber intended to facilitate the escape of the fluid from nozzles of the hydraulic motor and retain drain leaks of the fluid. In addition, the escape of the fluid from the Segner's wheel results in the aeration thereof which affects the normal operation of the pumps and other units of the hydraulic system.

There is also known a centrifuge for cleaning lubricating oils of an internal combustion engine comprising a base with a casing, a hollow vertical axle to pass the fluid being cleaned therethrough and deliver it to the interior of a rotating drum member journalled in bearings on the axle (cf., Pat. of Czechoslovakia No. 101,613, Cl 46 C 14, published September 15, 1961).

In the above centrifuge the drum member is likewise rotated by a built-in Segner's wheel-type hydraulic motor provided with nozzles and disposed in a separate chamber above the drum member.

A shield element is provided to prevent the fluid escaping from the nozzles from hitting the rotating drum. Ports for admitting the fluid arranged in a sleeve of the drum are covered by a baffle serving to prevent the impurities collected on the inner surface of the drum from being washed away.

The aforedescribed centrifuge disadvantageous in that the fluid is aerated. It is also excessive in size and weight due to the provision of a chamber accommodating the nozzles of the hydraulic motor, whereas the arrangement of the baffle intended to reduce the washing of impurities from the inner surface of the drum causes the centrifuge to consume more hydraulic power.

Another known centrifuge cleaner comprises a base, a casing, a hollow vertical stationary axle secured on the base and having mounted thereon a sleeve element with a drum member attached thereto, and fluid inlet and outlet pipes for supplying a fluid being cleaned to and discharging it from the interior of the drum member; this centrifuge bearing closest resemblance to the one to be described in the present specification (cf., G. A. Smirnov, et al "Novaya tsentrifuga dlya ochistki masla" — A New Centrifuge for Cleaning Oils, published in Russian by the TSNIITEneftekhim, Moscow, 1972, pp. 35-42).

The lower portion of the sleeve of the above centrifuge is provided with redial ports in alignment with tangentially arranged in the axle slots wherethrough the fluid being cleaned is conveyed into the interior of the drum, the upper portion of the sleeve having tangential ports for discharging the cleaned fluid from the drum.

The passage of the fluid through the tangentially arranged slots in the axle and through the ports and tangential ports in the sleeve causes by virtue of its kinetic nergy the sleeve and the drum to rotate for the separation of solid particles from the fluid under the action of centrifugal forces and deposition

thereof on the inner surface of the drum to occur. A drive means of this centrifuge is disposed inside the drum member which helps reduce its size and prevents aeration of the fluid being cleaned due to the lack of contact with the air.

However, high escape speed of the fluid from the tangential slots in the axle needed to attain a sufficient rate of rotation of the drum results in that the impurities settled on the inner surface of the drum are washed away which affects the quality of cleaning.

It is therefore an object of this invention to provide a centrifuge capable of high purity cleaning of working fluids of hydraulic systems through preventing impurities deposited on the inner side of a rotating drum from being washed away by jets of the fluid being cleaned entering the interior of the drum through ports arranged in a sleeve during the start-up and operation of the centrifuge.

Another object is to reduce hydraulic losses at the inlet of the fluid to and the outlet thereof from the interior of the drum, and consequently to reduce a pressure differential in the centrifuge accompanied by a reduction in hydraulic power consumed thereby while maintaining a high quality of cleaning.

These and other objects are attained by that in a centrifuge for cleaning working fluids of hydraulic systems wherein a sleeve carrying a drum member enclosed by a casing is journalled in bearings on a hollow vertical axle fixedly secured to a base of the centrifuge and having tangentially arranged slots for a forced delivery of a fluid being cleaned into the drum through ports in the sleeve in alignment with the slots, according to the invention, the centrifuge is further provided with a thin-wall perforated cylinder mounted inside the drum member coaxially therewith, a portion of the cylinder wall in the lower section thereof which faces the slots in the axle having no perforations.

Thanks to the above arrangement the jets of fluid being cleaned are directed to be thrown against the portion of the non-perforated inner wall of the cylinder and lose velocity whereby the impurities are prevented from being washed from the inner surface of the drum both during unstable operating conditions (for example, during start-up) and during unsteady fuel deliveries. Also, this arrangement does not call for additional expenditures of hydraulic power.

Preferably, the tangential slots in the axle disposed to face the non-perforated portion of the cylinder have sidewalls conforming to logarithmic spiral paths, whereas the tangentially arranged ports in the sleeve are of converging configuration.

The arrangement of the walls of the tangential slots in the axle to conform to a logarithmic spiral imparts to the flow of fluid being cleaned an increased tangential component of velocity at a reduced radial velocity resulting in reduced hydraulic losses due to a hydraulic shock at the inlet of the flow of fluid being cleaned to the ports of the sleeve of the drum member.

In addition, this arrangement of the slots in the axle of the centrifuge while providing a sufficiently high rate of rotation of the drum tends to reduce the radial velocities of the fluid jets entering the interior of the drums thereby reducing the effect of washing impurities from the inner surface of the drum.

The converging configuration of the tangential ports in the sleeve of the drum enables to bring down the velocity of the fluid entering these ports and, accordingly, to reduce the hydraulic losses in this area.

In view of the foregoing, thanks to the abovedescribed arrangement of the slots in the axle and the ports in the sleeve, hydraulic losses are reduced and consequently the amount of hydraulic power required to rotate the drum member of the centrifuge is also reduced, while efficient cleaning of the fluid is ensured.

The objects and advantages of the centrifuge embodying the present invention will be more fully apparent when reference is had to the accompanying drawings, in which:

Fig. 1 is a sectional schematic illustration of a centrifuge for cleaning working fluids of hydraulic systems according to an embodiment of the invention:

Fig. 2 is a cross-section taken along the line II-II in Fig. 1; and

Fig. 3 is a cross-section taken along the line III-III in Fig. 1.

A centrifuge for cleaning working fluids of hydraulic systems comprises a base 1 (Fig. 1) having fixedly secured thereon a hollow stationary vertical axle 2, rolling bearings 3 and 4, a drum 5 mounted on a sleeve 6, a casing 7, and inlet and outlet pipes 8 and 9 for admitting the contaminated fluid into the hollow axle 2 of the centrifuge and discharging the cleaned fluid therefrom. A passage 10 is provided in the axle 2 for admitting the fluid being cleaned to tangentially arranged slots 11 (Figs. 1, 2) with walls thereof conforming to a logarithmic spiral and further to ports 12 in the sleeve 6 of the drum member 5. In order to discharge the fluid from the interior of the drum member 5, ports 13 (Figs. 1 and 3) are tangentially arranged in the sleeve 6, the ports 13 being adapted to converge toward the centerline of the axle 2, the axle 2 having ports 14 (Fig. 1).

Noncontact packings or restrictors 15, 16 and 17 are arranged between the rotating sleeve 6 and the stationary axle 2 intended to restrict the leaks of the fluid and overflows thereof from the passage 10 to a pipe 18 which communicates with the outlet 9.

A perforated cylinder 21 is secured in grooves 19 and 20, the cylinder being fabricated from a thin sheet material and having a plurality of apertures 22 of a diameter considerably larger than the size of particles of impurities settled in the centrifuge, a portion 23 of the cylinder 21 arranged opposite the ports 12 having no apertures thereon.

The centrifuge operates in the following manner.

A fluid to be cleaned is admitted under pressure of up to 0.5 MPa through the tangential slots 11 of the axle 2 and the ports 12 to the interior of the drum 5. Having passed through the interior of the drum 5, the fluid is conveyed for discharge via the ports 13, 14 and the discharge pipe 18 and further to the outlet 9. The drum 5 of the centrifuge is rotated directly by the fluid being cleaned when it passes through said slots 11, ports 12 and ports 13. In the interior of the

drum member 5 under the action of the centrifugal forces the fluid is cleaned of impurities having great r specific gravity than the fluid.

The insert or perforated cylinder 21 (Fig. 1) arranged inside the drum 5 concentrically therewith and having a non-perforated portion 23 in the lower section thereof to face the slots 11 in the axle 2 and the ports 12 in the sleeve 6 acts to prevent impurities deposited on the inner surface of the drum 5 from being washed away by the jets of the working fluid escaping from the ports 12 both during start-up of the centrifuge and in the course of unsteady rates of delivery of the working fluid.

During starting the centrifuge the drum 5 rotates at a speed below the rated one for a while. In these conditions the centrifugal force is still negligeable, whereas the escape speed of the working fluid at the walls of the cylinder may be quite high to cause the impurities deposited on these walls to be washed away, if no means is provided to protect the deposits. Therefore, the provision of the perforated cylinder 21 helps reduce the relative velocity of the fluid in a gap between this cylinder and the inner wall of the drum 5 when steady-state operating conditions are not yet attained.

The velocity of the fluid in the interior of the drum 5 is most pronounced in the zone where the jets of fluid escape from the ports 12 of the sleeve 6. To protect the inner walls of the drum 5 from being acted upon by these jets, the section 23 of the perforated cylinder 21 facing the ports 12 has no perforations.

The provision of the perforated cylinder is most advantageous when the centrifuge is installed in discharge lines of hydraulic systems of vehicles characterized by sudden changes in the rate of delivery or consumption of the hydraulic fluid and the velocity of the fluid jets escaping into the interior of the drum from the ports 12 is in excess of the rated one. The perforated cylinder is also advantageous when used in a centrifuge installed in hydraulic systems using viscous fluids, for example, when hydraulically driven vehicles are operated in winter.

To reduce the velocity of working fluid jets escaping from the ports 12 of the sleeve 6 into the interior of the drum 5, the side walls of the tangentially arranged in the axle 2 slots 11 are adapted to follow a logarithmic spiral. This provision acts to reduce the radial speed of the fluid jets admitted to the ports 12 and escaping therefrom into the interior of the drum 5 without reducing the tangential component of [illegible] a speed, which component provides for the rated rotational speed of the drum 5. Therefore, the speed of the fluid jets thrown against the non-perforated portion 23 of the cylinder 21 is reduced, which prevents the impurities deposit d on the inner wall of the drum 5 from being washed away th rewith. The foregoing arrangements intended to prevent the washing away of the d posits result in a much better quality f fluid cleaning.

In addition, the structural modifications proposed heretofore help reduce the hydraulic power losses during operation of the centrifuge. In contrast to the centrifuges of known design where in order to prevent the washing of deposits use has been made of headpieces attached to the areas wherefrom the working fluid escapes into the interior of the drum resulting in an increased hydraulic resistance of the centrifuge, the herein proposed invention provides for the employment of an insert in the form of the perforated cylinder 21 spaced a sufficient distance from the ports 12 not to cause hydraulic power losses for the escaping jets of the working fluid thrown against the non-perforated portion 23 of the cylinder 21 to have a considerably lower speed than at the outlet from the ports 12. Also, the arrangement of the walls of the tangential slots 11 to conform to logarithmic spiral paths allows a more favourable admission of the fluid to the ports 12 thereby reducing the hydraulic power losses of the centrifuge.

For the purpose of a further reduction in the hydraulic power losses at the outlet of the fluid from the drum member, the ports 13 in the sleeve 6 are of converging configuration which facilitates the passage of the fluid therethrough and improves the orientation of the flow of fluid escaping from tangential ports 13, the latter fact also having an advantageous effect on the reduction of the hydraulic power losses and providing the rated rotation of the drum.

CLAIMS

1. A centrifuge for cleaning working fluids of hydraulic systems wherein a sleeve carrying a drum member enclosed by a casing is journalled in bearings on a vertical hollow axle fixedly secured to a base of the centrifuge and having tangentially arranged slots for a forced delivery of a fluid being cleaned into the drum through ports in the sleeve in alignment with the slots, the centrifuge being further provided with a thin-wall perforated cylinder mounted inside the drum member coaxially therewith, a portion of the cylinder wall in the lower section thereof to face the slots in the axle having no perforations.

2. A centrifuge as claimed in claim 1 wherein the tangential slots in the axle disposed to face the non-perforated portion of the perforated cylinder in the lower section thereof have side walls conforming to logarithmic spiral paths, whereas the tangentially arranged ports in the sleeve are of converging configuration.

3. A centrifuge as claimed in any of the claims 1 or 2 substantially as described with reference to the accompanying drawings (Figs. 1 to 3).

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1982.
Published at the Patent Office, [illegible] WC2A 1AY, from which copies may be obtained.